



STATE & PRIVATE FORESTRY FOREST HEALTH PROTECTION SOUTH SIERRA SHARED SERVICE AREA



Report Number: SS11-08

Title: Assessment of Stand Conditions Associated with a Jeffrey Pine Beetle Outbreak from 1991-1996 near Spooner Junction, Lake Tahoe Basin

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Report Highlights

- From 1991-1996 Jeffrey pine beetles (JPB) caused mortality across southern Lake Tahoe Basin during a drought period
- Census data were obtained for a 60-acre study area near Spooner Junction where mortality occurred in 44% of all host trees or 43% of all host basal area
- Stand conditions associated with this outbreak included: 302 SDI, 15" QMD, and 95% Jeffrey pine species composition
- JPB activity originated in dense areas where 1-acre units averaged 359 SDI, 240 feet² acre⁻¹ of basal area, and 42% canopy cover
- JPBs caused mortality at an average rate of 74 trees acre⁻¹ and mortality within 1-acre units increased with increasing forest density and canopy cover
- R5 hazard rating values previously identified are supported by these data; however, a slight reduction of minimum SDI threshold from 230 to 210 SDI is recommended

Multiple years of below average precipitation and suitable stand conditions led to a Jeffrey pine beetle (*Dendroctonus jeffreyi* Hopkins) (JPB) outbreak from 1991-1996 throughout the Lake Tahoe basin. Annual, individual tree surveys occurred in multiple locations around Lake Tahoe during this outbreak. Tree mortality was surveyed from a 60-acre study area near Spooner Junction where beetle populations reached epidemic levels in 1992 based on annual tree mortality expansion rates defined in Safranyik and Carroll (2006). The mortality documented is considered to be at the high end of potential JPB-caused mortality scenarios based on previous outbreaks near Lake Tahoe (pers. comm., D. Fournier, 1/5/11). This report documents stand conditions that were able to support multiple years of epidemic JPB populations near Spooner Junction and mortality levels that occurred.



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Stand-Level Forest Conditions and JPB-Caused Mortality from 1991-1996

The forested area where extensive JPB-caused mortality occurred near Spooner Junction was generally dense, composed of trees that averaged 15" diameter at 4.5 feet in height (DBH), and nearly pure Jeffrey pine (*Pinus jeffreyi*) species composition (Table 1). JPBs caused mortality in 4,580 out of 10,465 available Jeffrey pines. In total 44% of all host trees or 43% of total host basal area was killed from 1991-1996 at an average rate of 74 trees acre⁻¹.

Table 1. Study Area Forest Conditions in 1991 Prior to Jeffrey Pine Beetle Outbreak near Spooner Junction, Lake Tahoe Basin

Variable	n	Mean	Std Error	Median	Min	Max
Diameter at 4.5 feet in height (inches)	66	14	0.3	13	10	20
Quadratic Mean Diameter (inches)	66	15	0.4	15	10	22
Jeffrey Pine Species Composition (%)	66	95%	1%	98%	15%	100%
Stand Density (trees acre ⁻¹)	66	184	15	148	44	508
Basal Area (feet ² acre ⁻¹)	66	201	10	202	40	342
Stand Density Index (SDI)	66	302	16	317	66	539
Canopy Area (feet ² acre ⁻¹)	66	20828	1054	21845	4640	36637
Canopy Cover (%)	66	37%	2%	39%	10%	57%

Unit-Level Forest Conditions Associated with JPB-caused Mortality

A systematic grid was overlaid across the Spooner Junction survey area and delineated 77, 1-acre units. Eleven units were excluded from further analysis as they had less than 1/4th acre and represented meadows, woodlands and/or edge-effect. Individual trees within each 1-acre unit were utilized to calculate forest attributes and mortality statistics.

In 1991, JPB-caused mortality originated in 20 units that had significantly greater basal area, stand density index, and canopy cover compared to non-attacked units (Table 2). QMD and species composition were not different in attacked and non-attacked units. These 1991-attacked units supported an 8-fold increase in JPB-attacked trees from 1991 to 1992 (85 : 693 trees in 1991 : 1992).

Table 2. Mean ± S.E.M. Stand Characteristics for 1-Acre Units Attacked and Non-attacked by Jeffrey Pine Beetles in 1991 when Outbreak Originated

Stand Characteristic	1991 Attacked Units (n=20)	1991 Non-Attacked Units (n=46)
Quadratic Mean Diameter (in.)	15 ± .7a	15 ± .4a
Jeffrey Pine Composition (%)	96 ± 2a	95 ± 2a
Stem Density (trees acre ⁻¹)	210 ± 24a	172 ± 18a
Basal Area (feet ² acre ⁻¹)	240 ± 11a	183 ± 12b
Stand Density Index	359 ± 19a	277 ± 20b
Canopy Cover (%)	42 ± 2a	34 ± 2b

Note: differing letters following mean values represent significant difference based on Wilcoxon Rank Sum test (Hollander and Wolfe, 1973)

After 1991, JPB-caused mortality progressed in a spatially clustered pattern through time. A subsequent analysis to assess these spatial dynamics is being conducted by the Seattle University in collaboration with the USDA Forest Service. A report will be issued by Summer 2012 to document these results.

Overall, JPBs caused extensive mortality near Spooner Junction from 1991-1996 (Table 3). JPB-caused mortality (trees acre^{-1}) appeared positively correlated with forest density and canopy cover measurements (Appendix A, Figures 1 & 2). Statistical tests to verify significance and adjust for anticipated spatial autocorrelation occurred in a subsequent analysis (Egan et al., 2011). Percent JPB-caused mortality appeared to increase across varied unit characteristics as well (Appendix A, Figure 3).

Table 3. Jeffrey Pine Beetle-Caused Mortality from 1991-1996 within 1-Acre Units near Spooner Junction, Lake Tahoe Basin

Mortality Variable	n	Mean	Std. Error	Median	Minimum	Maximum
Stem Mortality (trees acre^{-1})	66	74	8	68	0	266
Stem Mortality (%)	66	38%	3%	35%	0%	91%
Basal Area Mortality ($\text{feet}^2 \text{ acre}^{-1}$)	66	80	8	66	0	264
Basal Area Mortality (%)	66	37%	3%	37%	0%	92%
Canopy Cover Loss (%)	66	12%	1%	10%	0%	41%

Implications for Hazard Rating

Prior hazard assessments that indicate 41% maximum JPB-caused basal area mortality are valid based on these data. Minimum QMD threshold value of 6" diameter at 4.5 feet in height are valid based on individual tree data (not shown) as only sporadic trees < 6" DBH were attacked in surveyed areas. Minimum SDI threshold for mortality of 230 SDI is valid; however, these data indicate a slightly lower 210 SDI minimum threshold should be considered.

These data also illustrate that Jeffrey pine beetle-caused mortality originated in dense pockets when assessed at the 1-acre spatial scale. These dense areas supported epidemic-scale population expansion from 1991 to 1992 (Safranyik and Carroll, 2006). Additionally, the greatest levels of JPB-caused mortality from 1991-1996 were located within these dense pockets. Thus, stands that average dense pockets of areas with high canopy cover and SDI values should be considered a greater hazard compared to similar stands without such dense pockets.

Citation for this report:

Egan, J., Bulaon, B., MacKenzie, M., Wenz, J. 2011. Assessment of Stand Conditions Associated with a Jeffrey Pine Beetle Outbreak from 1991-1996 near Spooner Junction, Lake Tahoe Basin. FHP Report # SS11-08. U.S. Department of Agriculture, Forest Service, Forest Health Protection, Sonora, CA. 6 pp.

Calculations Used

Basal Area

$DBH^2 * .005454$

Stand Density Index (SDI)

Stand Density Index (SDI) was calculated by summing individual tree SDI values derived from Reineke (1933) equations through the individual tree summation method that is described in Stage (1968). SDI values were calculated in manner consistent with equations utilized in Forest Vegetation Simulator programs.

Canopy cover

Calculations assume no canopy overlap as this stand was generally even-aged, pure composition Jeffrey pine. Canopy cover was calculated from individual tree DBH values as described in Keyser (2008).

QMD

Calculated as described in Curtis and Marshall (2000)

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Appendix A

Figure 1. Jeffrey Pine Beetle-Caused Mortality from 1991-1996 by Stand Density Index near Spooner Junction, Lake Tahoe Basin

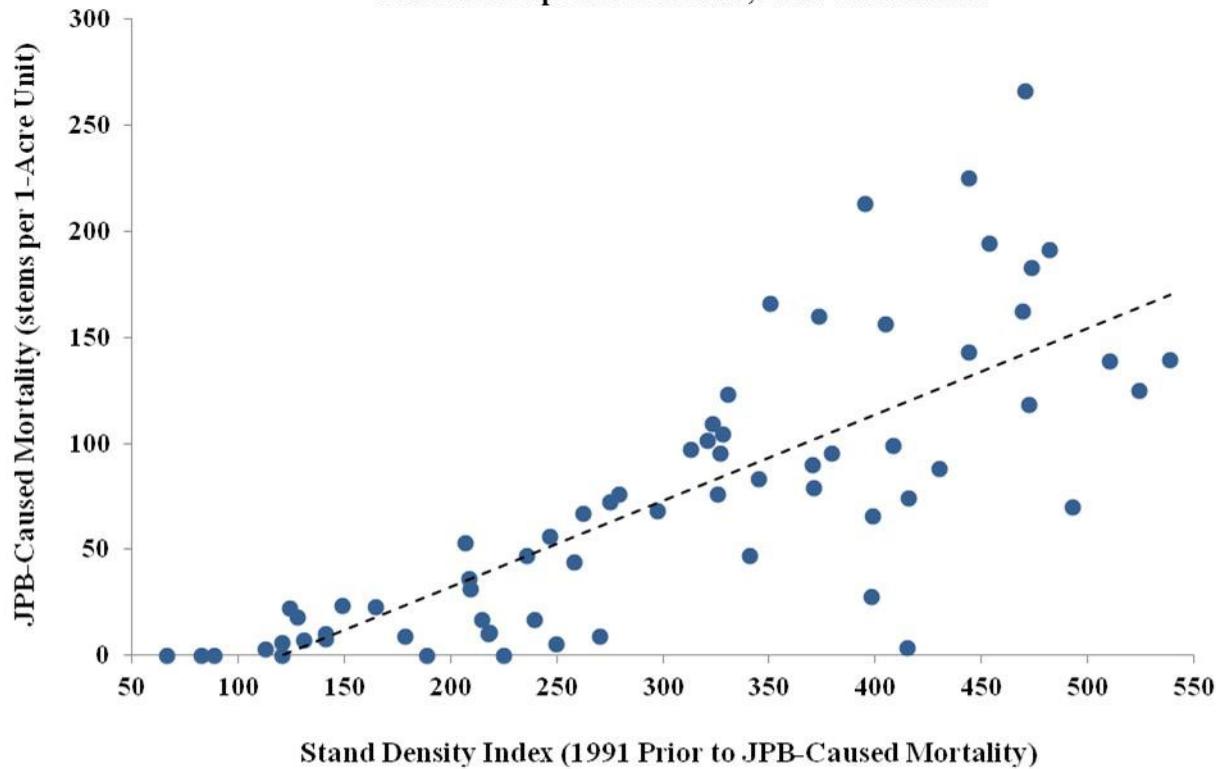
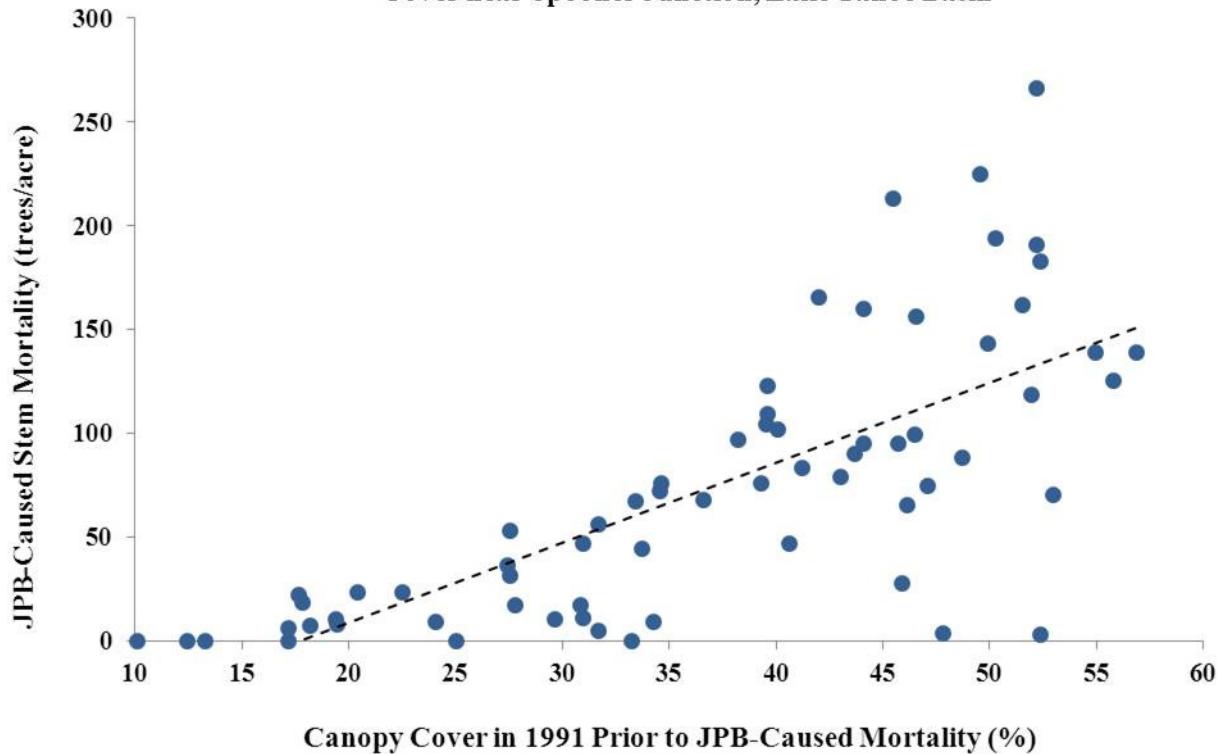


Figure 2. Jeffrey Pine Beetle-Caused Mortality from 1991-1996 by Percent Canopy Cover near Spooner Junction, Lake Tahoe Basin



Appendix A

Figure 3. Percent Jeffrey Pine Beetle-Caused Mortality by Stand Density Index from 1991-1996 near Spooner Junction, Lake Tahoe Basin

